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SAFETY INVESTIGATION REPORT

Accident to paramotor MACFLY 185, wing Dudek Universal 1.1 identified 78ASI on 1 July 2022 at Broué (Eure-et-Loir)

Time	09:10[1]
Operator	Uranus Paramoteur
Type of flight	Instruction
Persons on board	Student pilot
Consequences and damage	Student pilot fatally injured, paramotor destroyed
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Entry into uncontrolled sharp turn, collision with ground, in instruction

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the instructor's statement, the second student pilot's statement[2] and the examination of the paramotor.

Two student pilots, work colleagues and friends, were following training to obtain a paramotor pilot certificate. They had already carried out a first flight two days previously from the private strip reserved for paramotors where the training was taking place[3]. For each flight, the instructor gave a briefing on the ground during which he explained for the first time the exercises to be carried out. When the student was in flight, the instructor, on the ground, progressively gave his instructions over the radio.

The day of the accident, the two student pilots first carried out a few wing inflation exercises. At the end of these ground exercises, the other student pilot took off first and, at the instructor's request, flew an initial microlight strip circuit at a height estimated by the instructor as being between 100 and 150 m, followed by level flight into the wind at a height of 15 to 20 m. He continued with a second strip circuit followed by level flight at a height of around 5 m. He then gained height before carrying out a large 360° level turn in one direction and then in the other before landing.

It was then the student pilot's turn to take off to carry out the same programme. He used the same engine and harness assembly attached to another wing suitable for his weight. He carried out the exercises of this first flight of the day without any particular difficulties and landed.

[1] The times in this report are given in local time.
[2] This student pilot is referred to as the "other student pilot" in the rest of the report.
[3] *Base paramoteurs Paris Ouest*.

The other student pilot took off for the second flight of the day[4]. At the instructor's request and as seen during the ground briefing, he gained height and flew into the wind to familiarise himself with the wing pitching down in reaction to variations in engine speed, and carried out a "big ear" type manoeuvre[5]. The instructor then asked him to make a 360° turn at a height of between 100 and 150 m[6], tighter than on the previous flight, in one direction then the other, before lining up into the wind to make three touch-and-goes and to land.

The student pilot then took off for the second flight of the day and carried out the pitching down and “big ear” exercises without any difficulty. During the first 360° turn, he did not manage to exit the turn into the wind and carried out several turns. The instructor asked him to gain height to re-start the exercise which he had not correctly performed. At the end of the 360° turn, instead of returning to straight flight, the wing continued turning gaining in speed, in descent. The instructor asked the student pilot several times to raise his hand: the student had no visible reaction. The spiral descent continued until collision with the ground.

Just after the collision with the ground, the wing was still inflated and the engine sharply accelerated for several seconds before stopping.

The other student pilot immediately went to his friend and gave first aid care, but was unable to revive him before the arrival of the emergency services.

2 ADDITIONAL INFORMATION

2.1 Examination of site and wreckage

The accident site was in a flat wheat field with no obstacles next to the microlight strip. There was a windsock at the edge of the strip.

The paramotor harness and chassis were found around five metres from the initial point of contact with the ground. The examination of the harness titanium frame identified substantial deformations on the left side. Soil marks and deformations were also visible on the lower left side of the chassis and on the propeller cage. These observations are consistent with the paramotor having a left bank and steep nose-down attitude at the time of the collision. The harness and chassis then bounced, and the propeller still rotating, caught the risers on the right side which wound themselves around the propeller hub until reaching the wing.

[4] The instructor does not formally remember whether the various exercises on the day of the accident were carried out during the same flight or during two separate flights for each pilot, but he added that the latter was likely. The other student pilot said that they had each carried out two flights.

[5] Manoeuvre where the pilot pulls a riser on each side to close the wing tip to increase the rate of descent.

[6] The other student pilot explained that in his mind, the request to fly a 360° turn was not restricted to one turn and that it was possible to do up to two or three turns.

2.2 Paramotor information

The instructor was the owner of the paramotor.

The Macfly 185 paramotor was composed of the following elements:

- SOL Comfort Evolution 2 harness – size L/XL;
- chassis (with its propeller cage and netting);
- Vittorazi Moster 185 Plus counterclockwise engine;
- E-Props 125 cm two-blade propeller;
- 12 l fuel tank.

For the accident flight, it was associated with a 28 m² Dudek Universal 1.1 wing.

The paramotor manufacturer specified that the choice of engine and harness was consistent with the build and weight of the student pilot. The Total Flying Weight (TFW), i.e. the combined weight of the chassis, harness, engine and pilot, was within the envelope defined by the DGAC approval to use the wing with a paramotor (90 kg – 140 kg).

2.2.1 Vittorazi Moster 185 Plus engine

The engine developed 25 hp (18.6 kW) at 7,800 rpm. The instructor bought the engine new in November 2021. He kept a record of its operating hours: on the day of the accident, it had been used 62 times for a total operating time of 26 h. During the flights immediately before the accident flight, the engine had not experienced any faults.

This type of engine is equipped with a centrifugal clutch to cancel the propeller torque when the engine is idling. The torque marks observed on the propeller made it possible to determine that the engine was operating at the time of the collision with the ground and was providing power immediately after.

2.2.2 Examination of wing and paramotor

The Universal 1.1 wing is suitable for novice or occasional pilots. The microlight identification sheet specifies that it can be used with an engine developing a maximum of 27 kW (i.e. 36.2 hp). The instructor had bought it new in July 2021.

He had chosen this wing based on the student pilot's weight. His friend, who was lighter, used another, smaller wing.

The wing flight manual specifies that the Universal 1.1 is a very agile wing, and entering a 360° sharp turn can happen very quickly. This can surprise pilots with little experience. The manual adds that if the spiral continues after releasing the brakes, the pilot should use the external brake.

The riser attachment points on the paramotor "gooseneck" movable arms are asymmetrical by design. In the case of a counter-clockwise rotating propeller - as was the case for 78ASI - the ring on the right-hand movable arm is moved forward to cancel the torque that tends to cause the paramotor to pull to the right. In addition, the movable arms have a slight torsion on the right to shift the centre of gravity of the pilot/paramotor assembly to the left in relation to the wing attachment points, thus countering the propeller torque in level flight. These settings are optimised for cruising: at higher power levels, the wing will roll to the right; at lower power levels, the wing will roll to the left.

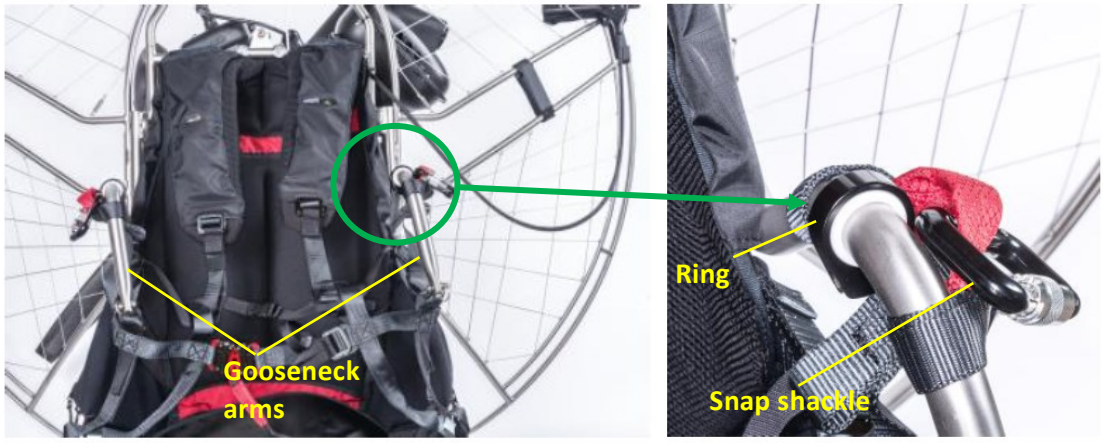

Figure 1: "gooseneck" movable arms with rings holding snap shackles
(source: Macfly user manual, March 2022 edition, modification[7] and annotations BEA)

The examinations carried out by the BEA found that the trims were symmetrically set to the take-off position. The rings to position the riser snap shackles on the movable arms were close to or in the factory setting, compatible with the weight of the student pilot. The height setting of the brake control grips complied with the manufacturer's specifications. The measurement of the risers, and the wing setting and symmetry did not reveal any anomaly. The wing was recent and in good condition before the accident; all the damage observed was the result of the risers and then the wing rolling around the propeller, after the collision with the ground, when the engine accelerated.

The right fastener connecting the lower rear section of the harness to the chassis was found detached. This fastener improves the junction between the harness and the chassis. It was not possible to determine whether this condition was the result of the accident. Tests carried out on the paramotor manufacturer's gantry did not show any significant influence on the paramotor's behaviour if this condition had existed prior to the accident. According to the manufacturer, the effect in flight was not significant.

The examination of the site and the wreckage did not identify any anomaly that could have contributed to the accident.

2.3 Meteorological information

The meteorological conditions estimated by the French met office, Météo-France, were the following: clear sky with a westerly wind of around 10 to 15 km/h. The temperature was approximately 14°C. No low-level phenomenon was identified.

The instructor specified that the weather conditions were favourable for flight, with a light wind without turbulence and clouds.

[7] The illustration in the manual shows an assembly for a clockwise rotating motor. Here it has been inverted to show a similar assembly to that of 78ASI.

2.4 Student pilot information

The 33-year-old student pilot did not hold any pilot licence. A sportsman, he was a military parachutist and was qualified as an operational jumper (controlled high altitude-high opening jumps) since June 2021. He had made a total of 158 jumps, including four in May 2022. Most of his jumps were made with G9 parachutes with a surface area of 33 m². These canopies have a very thick profile and are characterised by their high stability and low reactivity, requiring strong, large amplitude actions on the controls. He also jumped with other smaller training canopies, suitable for beginners and with similar characteristics.

When he enrolled for the paramotor training course, the student pilot declared that he had no health problems. His physical fitness was monitored every two years in the scope of his professional activity.

The autopsy revealed that he had not eaten since the previous day. Statements indicated that it was not unusual for the student pilot to refrain from eating breakfast. Generally speaking, a state of fasting (blood sugar level, hydration) can impair a person's ability to adapt to quick accelerations and have an impact on piloting performance. Combined with a state of fatigue, this ability to adapt can be further impaired.

2.5 Instructor information

The 63-year-old instructor held an aeroplane private pilot licence obtained in 1986 and a microlight certificate with fixed-wing, flex-wing and paramotor ratings. He held a paramotor instructor rating obtained on 3 June 2021.

He set up the Uranus Paramoteur flying school in June 2021.

2.6 Statements

2.6.1 Instructor

The instructor explained that the student pilot had contacted him the previous week to take a course with one of his friends, over a few days, to obtain a paramotor pilot certificate. They signed up on Tuesday 28 June. That day, the instructor explained to them how to inflate the wing on the ground in different wind configurations. The two student pilots then familiarised themselves with the engine's operation, making ground runs with the engine, without the wing, to learn how to control the engine's thrust and torque.

The following morning, Wednesday 29 June, they practised inflating the wing again and then made ground runs with the engine and wing, without taking off[8]. At the end of the morning, they took it in turns to carry out their first flight, which consisted of a microlight strip circuit with the turn being carried out with a slight bank angle. As on the day of the accident, the two student pilots used the same harness and the same engine, but they each flew with a wing adapted to their weight.

[8] The inflation exercises were carried out with different wings to those used for the flights, so as not to expose them to the morning dew.

The instructor explained that before he got his students to make any turns, he asked them to reduce throttle in order to limit the gyroscopic effects generated by the rotation of the power unit.

The weather conditions on Thursday did not permit flight. They met up again on Friday morning for their second flight. Once again, they began the session with wing inflation exercises. The instructor explained that the two student pilots had previous experience of parachuting and were clearly at ease with handling the wing. Not being a parachutist himself, the instructor was not aware of the differences in behaviour that can exist between a parachute and a paramotor wing.

He observed that the student pilot had not correctly carried out the first steep 360° and that he was not correctly aligned when he exited the turn. This did not seem unusual to him at this stage of the training and was not such as to call into question the continuation of the flight; it simply deserved to be highlighted during the debriefing at the end of the flight. He asked him to perform another 360° after regaining height.

At the end of the second 360° turn, the instructor did not see the student pilot raise his hand on the inside of the turn as he asked him to do several times on the radio. He explained that this action would have been enough to stop the turn. He reported that the wing continued to turn and accelerate in a sharp turn. The instructor thought that the last turn was to the left.

The instructor explained that just after the collision with the ground, he heard a quick acceleration of the engine for a few moments, probably due to tension applied to the throttle cable.

The instructor remembered that, after the accident, the other student pilot told him that his friend had not slept well and was feeling tired.

He added that the paramotor was asymmetric by design. This asymmetry counters the propeller torque in straight, level flight, but requires corrections to the flight path as a function of engine speed. The torque pulls the paramotor to the right when power is applied, as is the case for the initial climb; conversely, the paramotor tends to pull to the left when throttle is reduced. When starting a left turn with the engine idling, the pilot has to make a smaller, lighter input than when starting a right turn. The instructor considered that the difference in input between the right and left turns may have surprised the student pilot.

He added that when he first presents the paramotor to his students, he shows them in particular the asymmetry of the “gooseneck” movable arms by explaining their usefulness (compensation of the propeller torque in level flight) and underlines the asymmetric behaviour of the paramotor at different speeds (full throttle and idle). Then, during the first flights, he systematically reminds his students of the propeller torque effects and how to correct them.

2.6.2 Other student pilot

The other student pilot explained that, as they were both already parachutists, they had not experienced any difficulties or felt they were in danger when carrying out the exercises since the start of the training. He added that the flights were briefed with the instructor before take-off and the instructions were repeated as the flights progressed in a reassuring manner.

At the end of the first flight, two days earlier, the two friends had exchanged their impressions with each other: they felt confident.

He specified that during the second flight on the day of the accident, the instructor asked them to perform one or more tighter 360° turns than on the first flight, in one direction and then the other. His friend seemed to have difficulty controlling the wing during this manoeuvre and made several turns before coming out of it. The instructor asked him to gain height and try again.

On trying again, the instructor asked the student pilot to exit the turn, which he did not do. The instructor then urged the student pilot to let go of the controls, while the paramotor continued to turn in descent, which the student pilot did not do. The other student pilot added that at the end of the descent, at very low height, the wing seemed to take a straight path, but the student pilot was unable to avoid collision with the ground.

He added that the student pilot had not had a good night's sleep, but that his behaviour on the day of the accident seemed normal.

2.7 Framework for paramotor training

There is no formal framework for training paramotor pilots. The French microlight federation (FFPLUM) has defined a "paramotor student syllabus", which includes a number of modules comprising exercises that the student pilot must complete satisfactorily before taking an aptitude test. This syllabus is not subject to any criteria linked to the number of flight hours and is based solely on the instructor's assessment. Generally speaking, basic training to fly a paramotor requires few flight hours.

The first module defined by the FFPLUM consists of exercises in inflating and controlling the wing on the ground, first without the engine, then with the engine shut down and finally with it running. The first flight is then carried out, consisting of a runway circuit.

The second module involves mastering the wing in flight through a series of exercises such as level turns, pitch and roll control, and autonomy for the take-off and landing phases. Possible steep turns can be performed when in this phase of the training.

The successive exercises described by the witnesses and the way they were carried out were consistent with the syllabus proposed by the FFPLUM.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

This was the student pilot's third instruction flight, following on from a friend on the same course. The instructor had quickly noticed that both students were very at ease handling their wings, both having prior parachuting experience.

After encountering difficulties performing a 360° turn with the engine idling, the student pilot started the exercise again. He then entered a sharp turn from which he did not recover despite his instructor's instructions. The examination of the wreckage indicated that this turn was to the left, a direction that by design requires a smaller, lighter input on the controls than a right turn.

Contributing factors

Being used to parachutes that are less reactive than the wing of a paramotor, it is possible that the student pilot made an excessive input on the brake control during the start of the turn, explaining the entry into a sharp turn. However, the student pilot's experience as a parachutist could have spontaneously prompted him to exit the turn.

The instructor stated that he did not see him raise his hand on the inside of the turn as he instructed, which would have been enough to stop the turn.

The investigation was unable to establish the reasons for the student pilot's apparent lack of action to exit the turn.

The fact that the student pilot had not eaten since the previous day, associated with a possible state of fatigue following a bad night, might have impaired his ability to withstand the accelerations induced by the start of the sharp turn, and might have contributed to his failure to react to exit the turn.

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.